Regional Multi-stakeholder Consultation on
MRC's Hydropower Programme
25-27 September 2008
Vientiane, Lao PDR

Modelling of Flow Changes in the Mekong Mainstream for a Range of Water Resources Development Scenarios

Preliminary Results

Outline of the Presentation

1. Purpose of modelling flow changes
2. Approach and process
3. Main findings
4. Next steps

1. Purpose of Modelling Flow Changes

1. To assess changes in some hydrological impact indictors caused by possible water resources development scenarios in the Lower Mekong Basin (LMB)

2. To facilitate discussion and decision making

3. To define the scope of a more comprehensive scenario assessment (environmental, social and economic impacts)

2. Approach and Process

The Approach

- All water and related sectors are considered. Preliminary focus on hydropower development and impacts on the mainstream

- Six possible scenarios under three situations: 1) **Baseline**, 2) **Definite Future** and 3) **Future Plan in the LMB**

- Initial assessment of changes in water flows, water levels, flooding and salinity intrusion

Sectors considered

- Water supplies (domestic and industrial uses)
- Irrigated agriculture
- Hydropower
- Fisheries
- Navigation, transport, river works
- Flood management and mitigation
- Tourism and recreation (water-related)
- Watershed management
- Environment, including water demand of ecosystem

Scenarios Considered

Baseline

Baseline year 2000

Baseline

\+

Existing and planned
Dams in Upper Mekong

Upper Mekong Dam

Definite Future

\+

Existing and under-construction
dams in LMB

Definite Future

\+

Planned LMB
mainstream dams

LMB Mainstream Dam

\+

Planned LMB
tributary dams

LMB Tributary Dam

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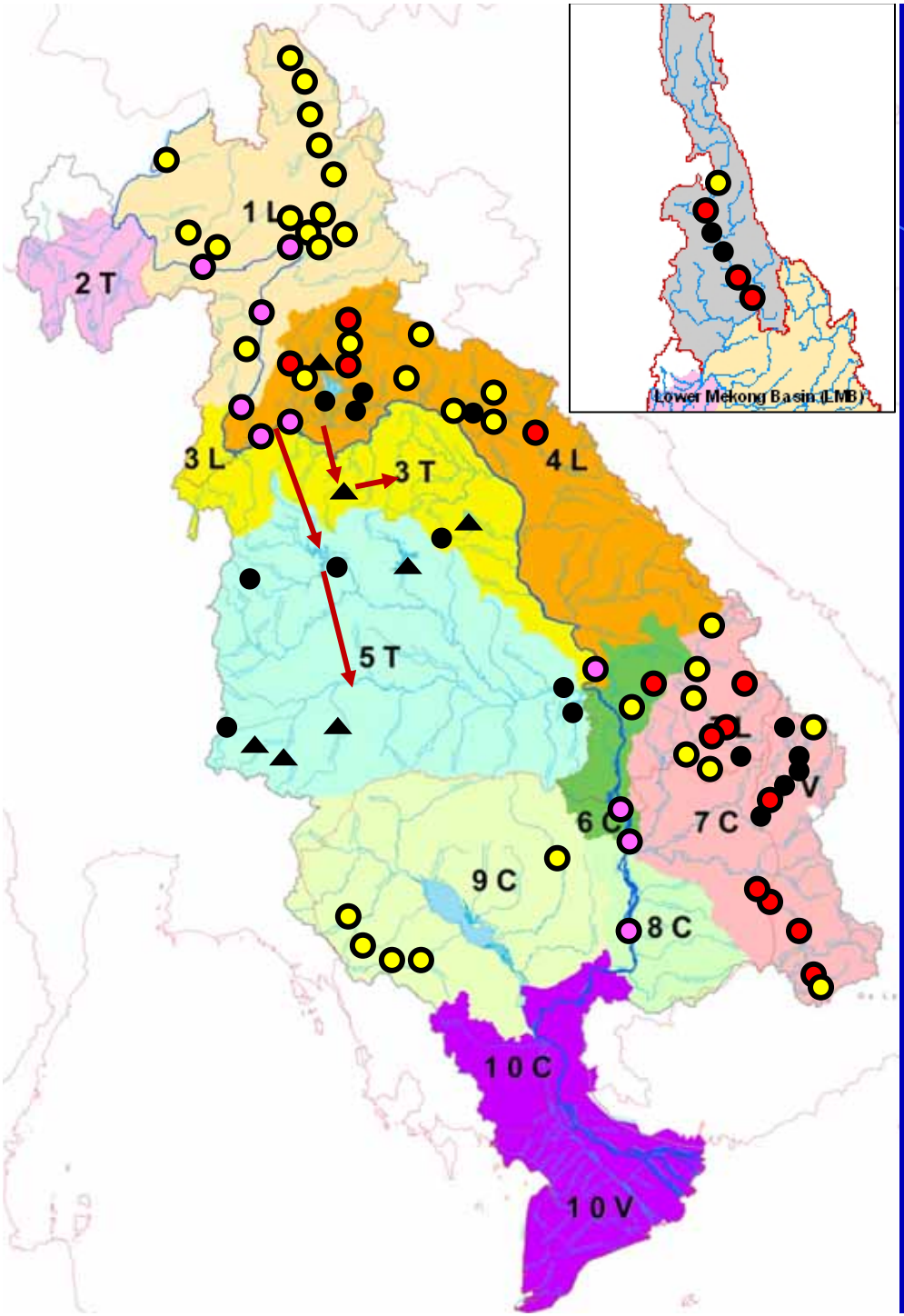
Future Plan

Planned LMB
irrigation and water supply

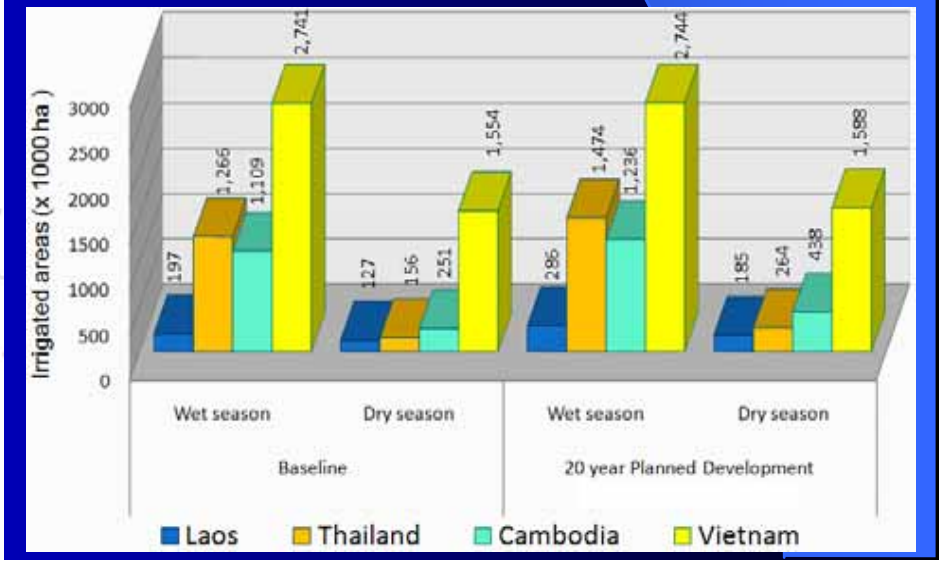
LMB 20-Year Plan



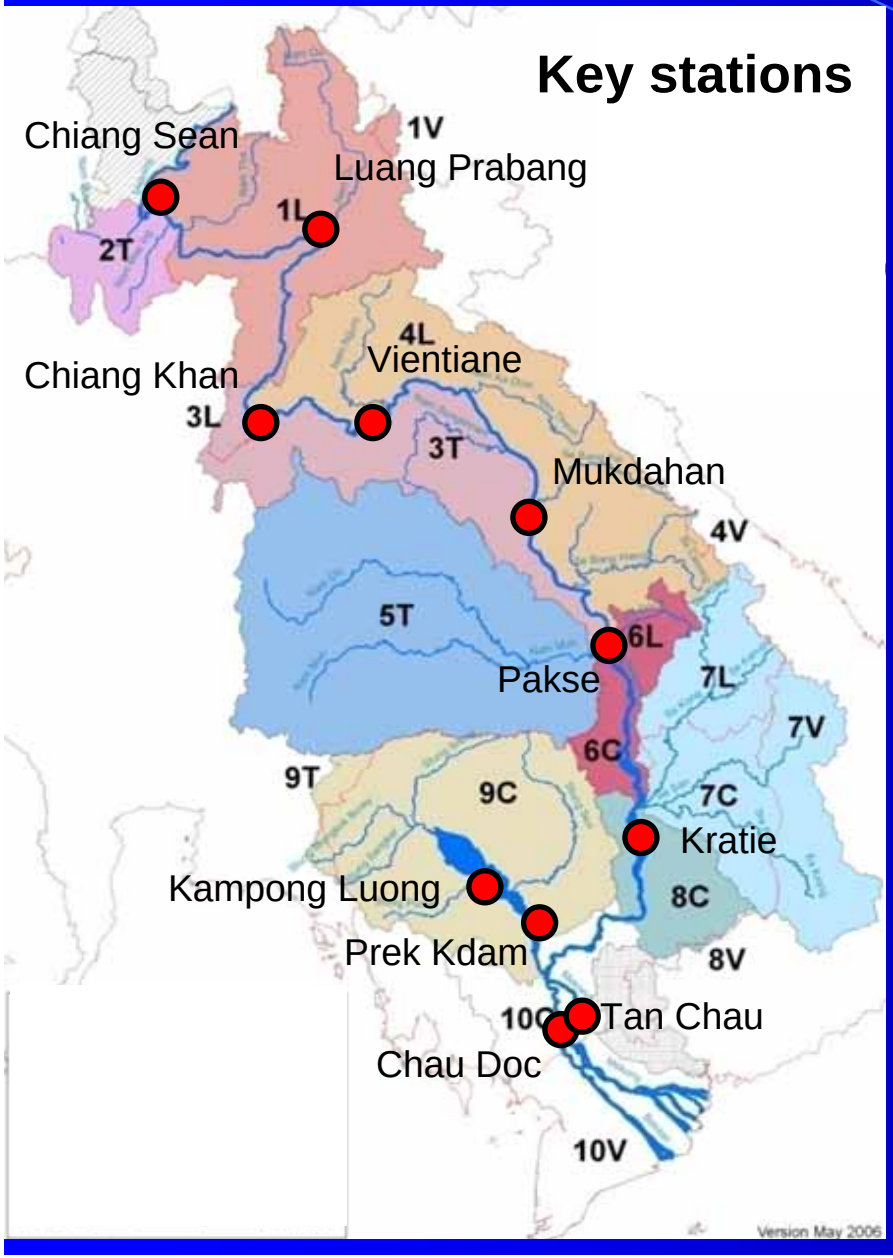
Hydropower

Scenario	No Project	Installed Capacity (MW)	Active Storage (MCM)
Baseline	11	1,553.2	9,638.2
Upper Mekong Dam	17	17,003.2	32,871.2
Definite Future	35	21,073.2	44,003.9
LMB Mainstream Dam	45	35,152.2	48,909.9
LMB Tributary Dam	70	26,728.2	71,936.9
LMB 20-year Plan	80	40,807.2	76,843.9

Irrigation



Selected Indicators



➢**Changes in flow and water level**

- Average seasonal flow and water level
- Average monthly flow and water level
- Daily flow and water level duration curves
- Annual average minimum and maximum flow and water levels
- Flow during wet, dry and average years

➢**Changes in floodplain in Tonle Sap and Vietnam Delta**

- Flood inundation area (>0.5 m water depth)
- Flood timing, duration and volume

➢**Changes in salinity intrusion in Vietnam Delta**

- Salinity intrusion concentration
- Salinity intrusion duration

Main Assumptions

- Climate conditions from 1985-2000 will still represent the variability of climate in the next 20 years
- The hydropower cascade in the Upper Mekong Basin will be operated to maximize electricity production within the variability of historical inflow data
- The mainstream dams in the LMB will be constructed and operated in accordance with their current preliminary designs

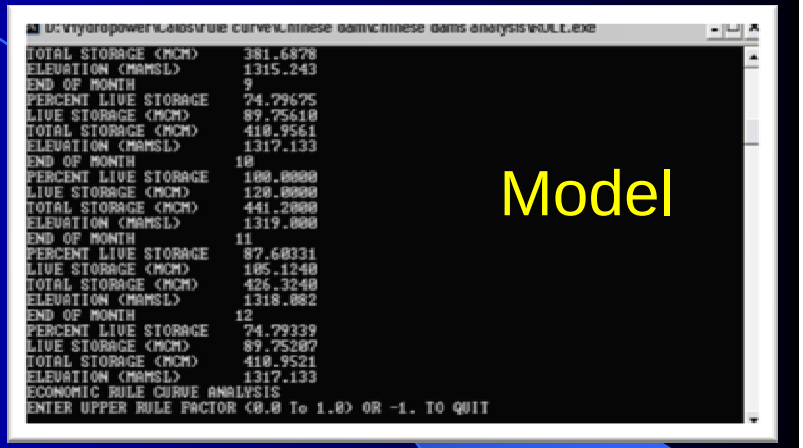
The Process

- Scope and definition of scenarios and assessment indicators discussed by NMCs, line agencies, other regional organizations
- Improved input data through sector reviews with line agencies, NMCs and other partners
- Joint work between BDP, IKMP and modelling specialists from the Member countries
- Results will be discussed in various forums
- Determination of scope and process and methods for more comprehensive assessment (environmental, social and economic)

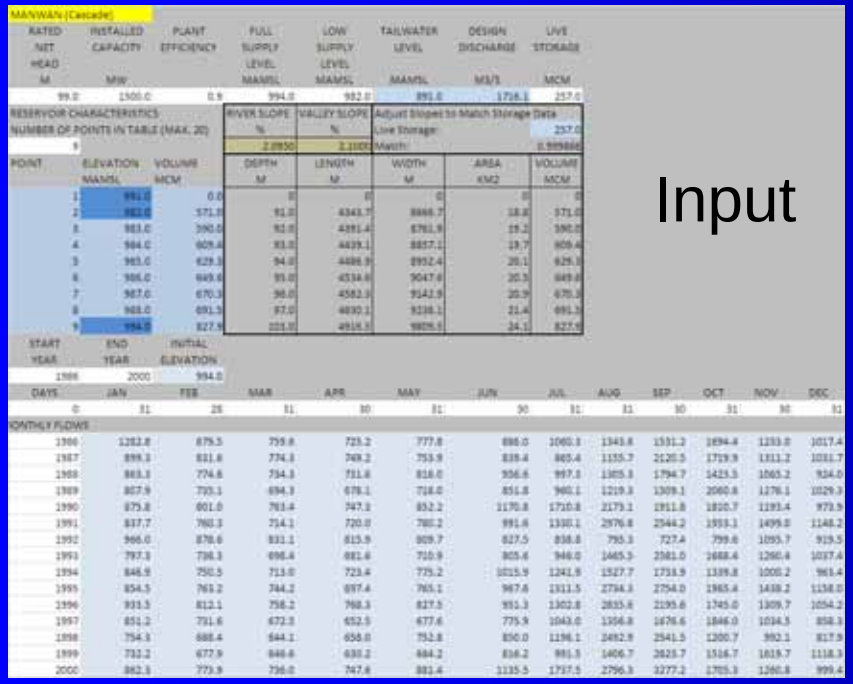
The Tools

Hydropower Operation Rule Model

- Single dam
- Dam cascade

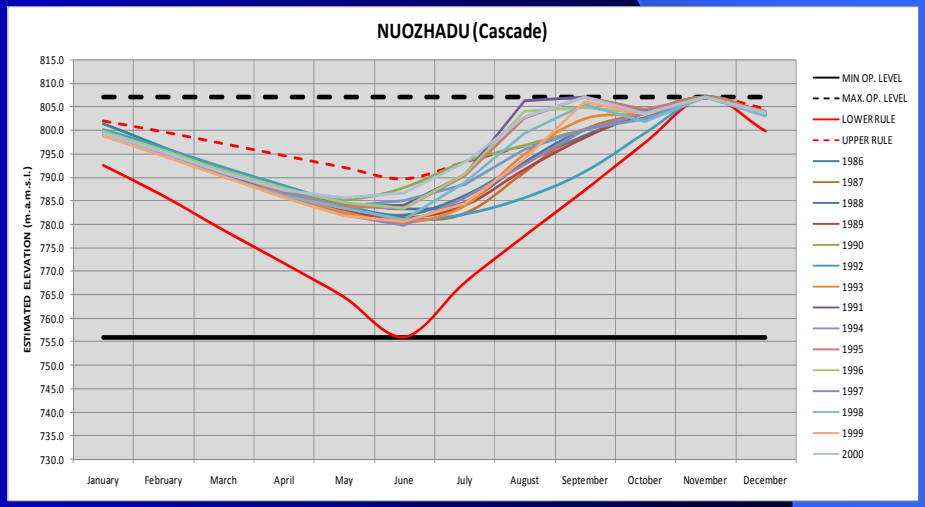


Model



Input

Output



The Tools (2)

MRC Decision Support Framework (DSF)

Knowledge Base

Planning and monitoring data such as:

- hydrological records
- physical data
- socio-economic and environmental data
- scenario description data
- simulation model input data
- simulation model results

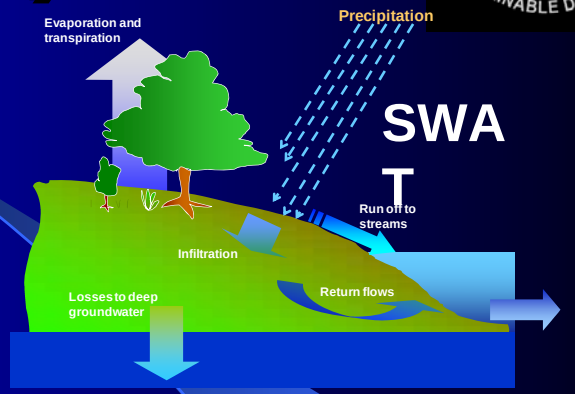
DSF User Interface and Tools

Basin Simulation Modelling Package

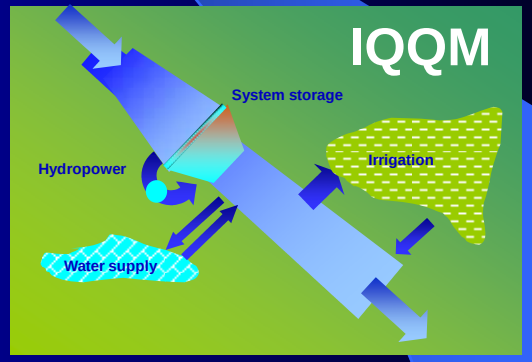
- *SWAT*
- *IQQM*
- *ISIS*

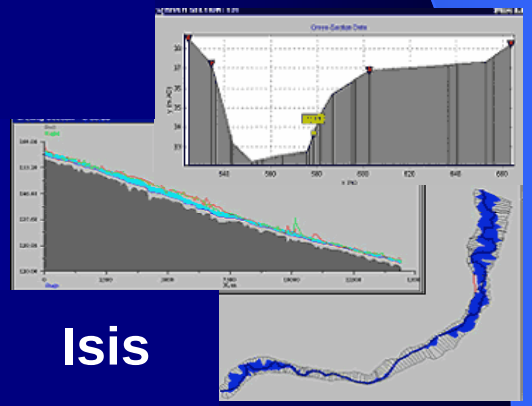
Impact Analysis Tools

Reporting Tools



SWAT





Isis

3. Main Findings

Finding 1 – Definite Future Scenario vs. Baseline

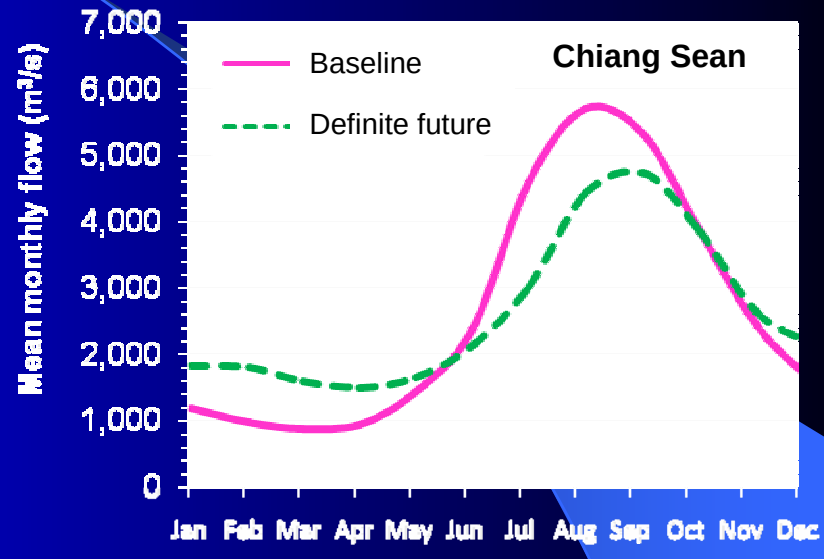
- The **Definite Future Scenario** will change the mainstream flows:
  - The average dry season flow will increase by 30-50% in the northern part of Thailand and Laos, which is higher than the historically observed range
  - The large increase in the dry season flow decreases gradually in downstream direction to about 10% in the Vietnam Delta, which would provide a good safety factor against salinity intrusion
  - The wet season flow in the upper part of LMB will reduce with some 10%, while reductions in the downstream part are very small

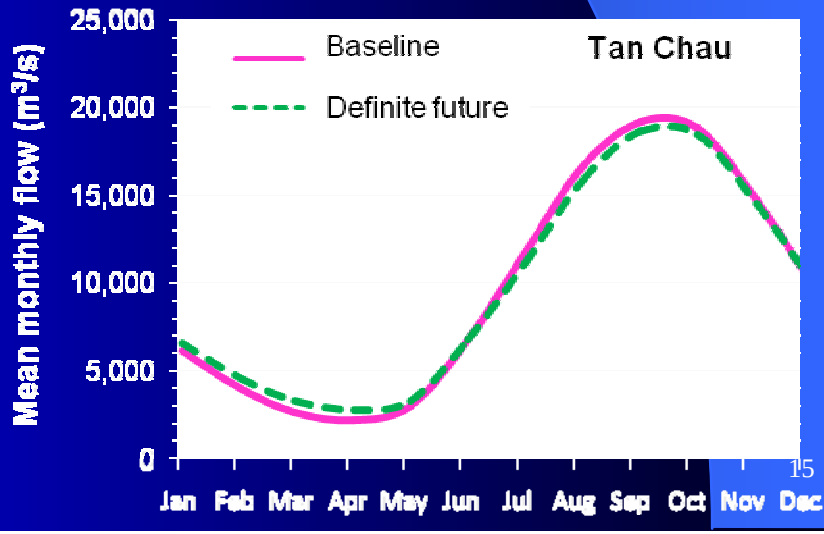
Average flow change in dry and wet seasons

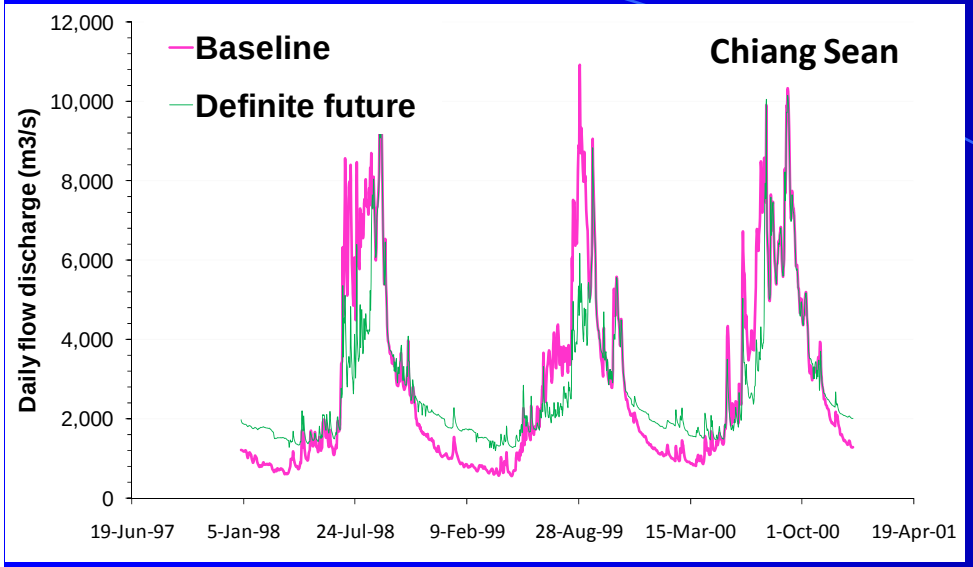
Definite Future vs. Baseline

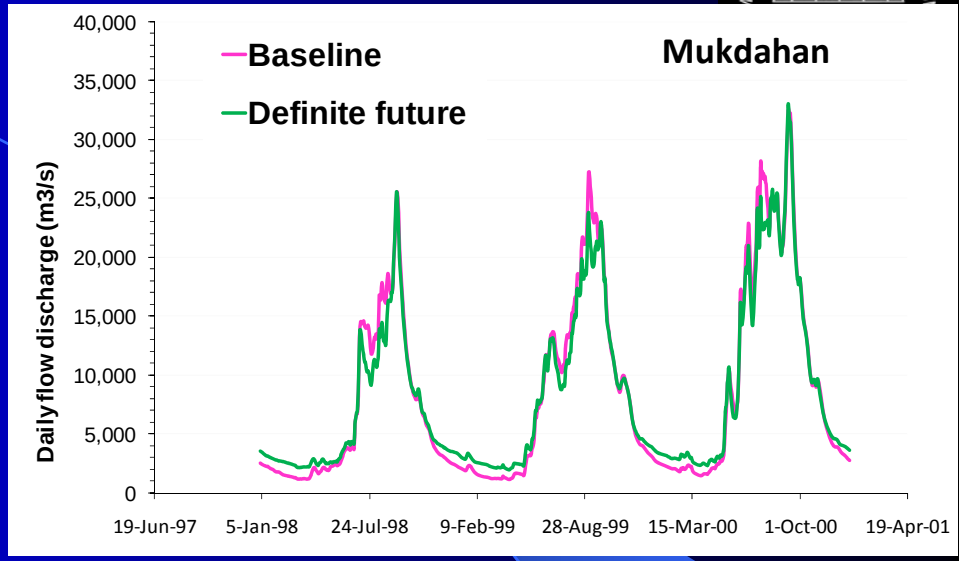
%

Station	Wet (Jun-Nov)	Dry (Dec-May)
Chiang Sean	-14.57	48.11
Luang Prabang	-9.84	37.90
Chiang Khan	-8.89	35.31
Vientiane	-8.64	34.84
Mukdahan	-6.08	30.14
Pakse	-4.82	26.77
Kratie	-4.01	20.62
Tan Chau	-2.78	9.76
Chau Doc	-3.57	9.22

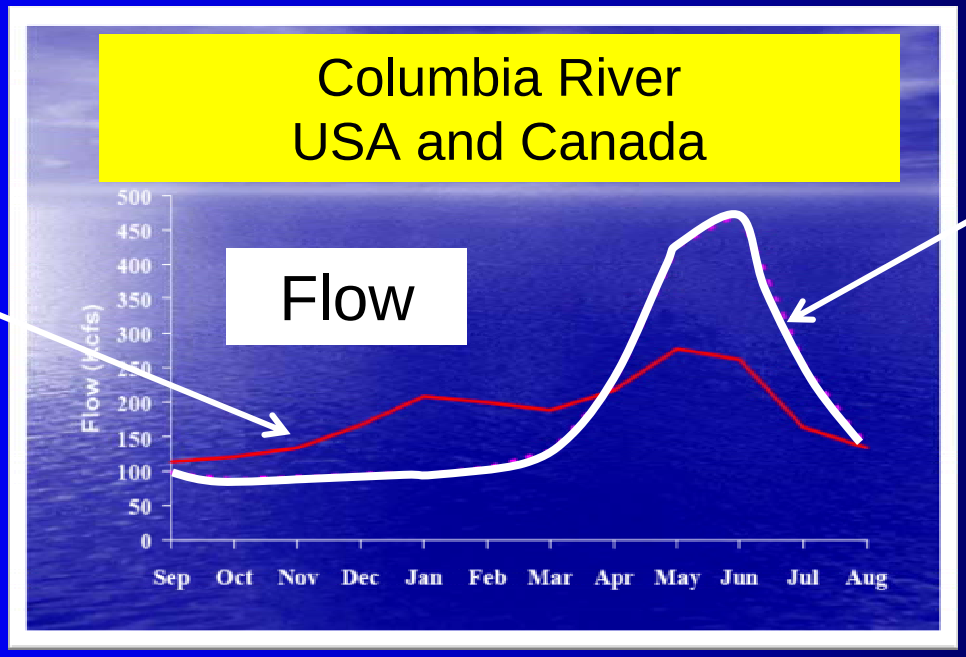








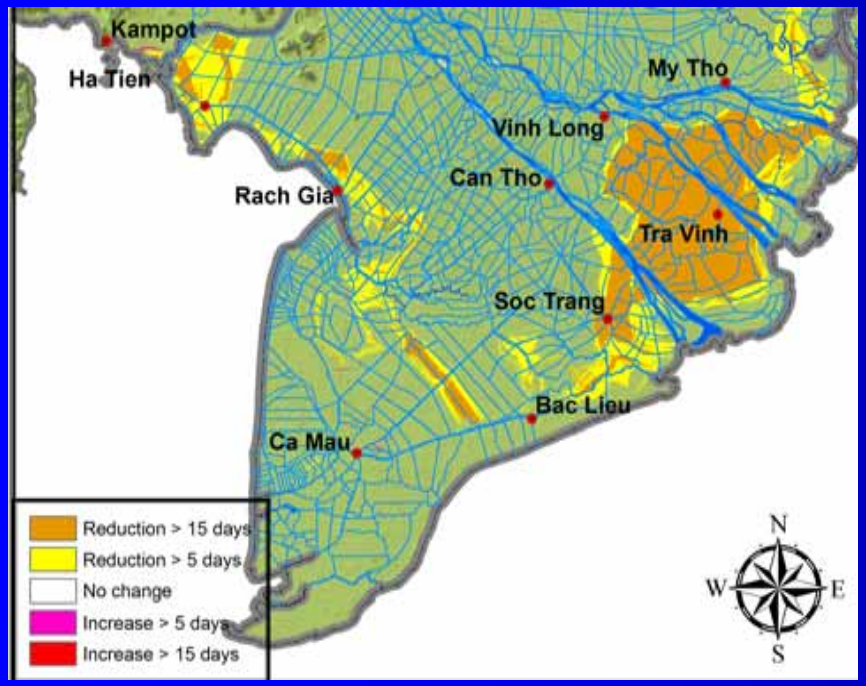
Regulated



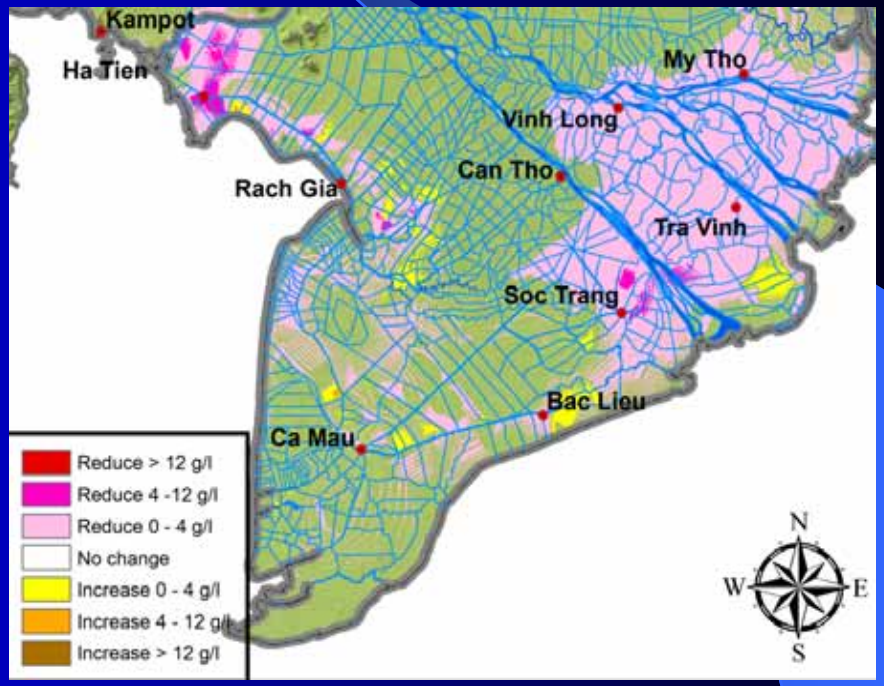
Natural

Changes in salinity concentration and duration in a dry year

Definite future vs. Baseline



Salinity Intrusion Duration (days)



Salinity concentration (g/l)

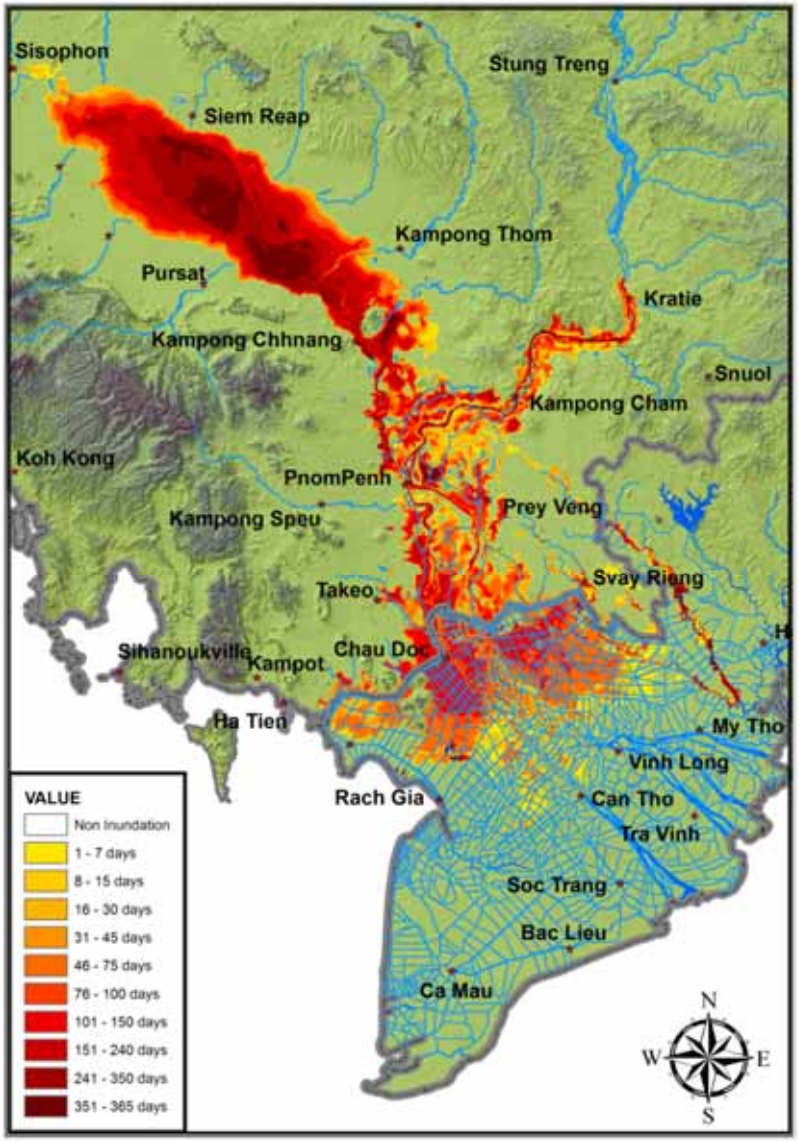
Finding 1 – Definite Future Scenario (Continued)

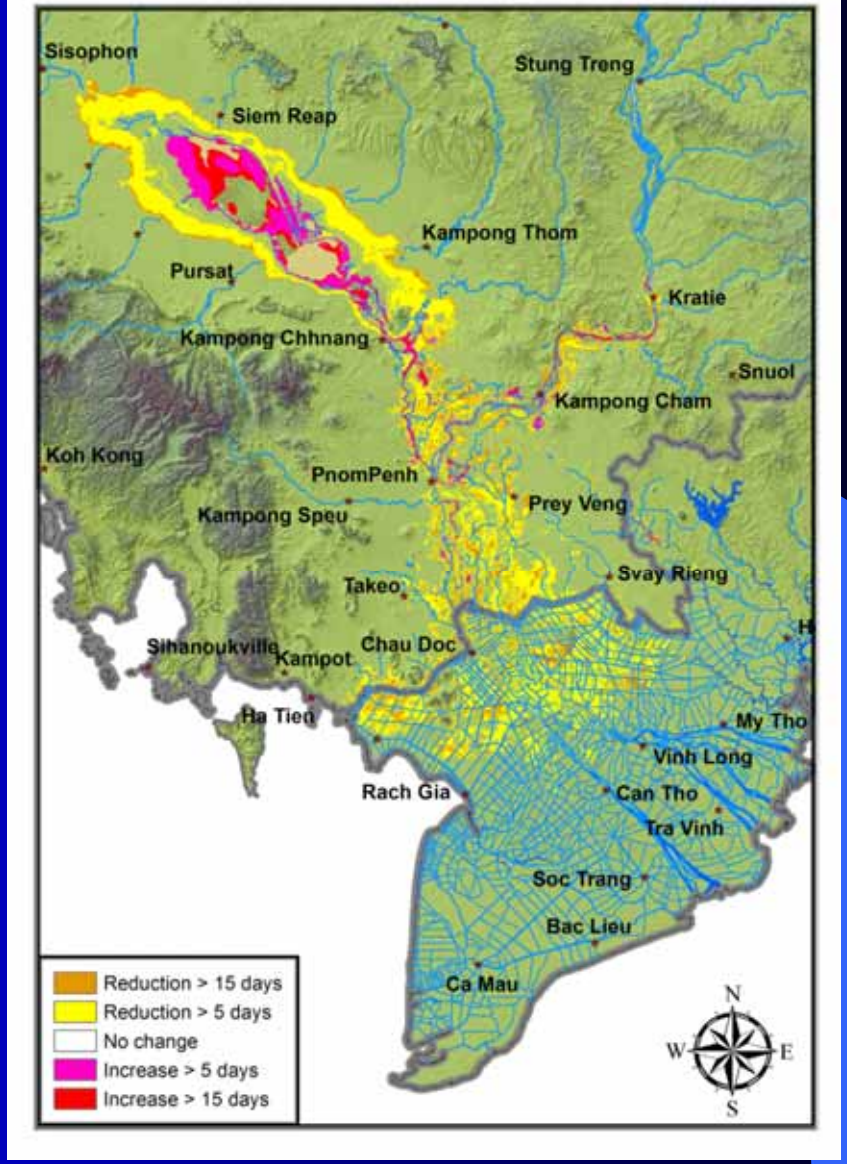
- The **Definite Future Scenario** will marginally change the volume, duration and timing of the flood pulse in the downstream part of the LMB. The calculated changes constitute a fraction of the historically observed natural year-to-year variability:
  - Reduction up to 7.5% of reverse flow and 5.4% of outflow from the Tonle Sap Lake
  - Reduction in the range of 5 to 15 days (5 to 10%) in flood duration in parts of the baseline flooded areas and an increase of 5-15 days in the Tonle Sap Lake
  - Timing of flooding changes with 1-3 days

Changes in timing, duration and volume of flooding for various scenarios compared to the Baseline

Indicators	Reverse Flow to Tonle Sap				OutFlow from Tonle Sap			
	Start date	Duration (days)	Volume (MCM)	Mean WL (m)	Start date	Duration (days)	Volume (MCM)	Mean WL (m)
Baseline	23-May	121	-36,040	5.18	26-Sep	231	65,330	3.90
Chinese Dam	23-May	122	-34,174	5.08	29-Sep	229	62,830	3.97
Definite future	21-May	123	-33,468	4.99	27-Sep	228	61,913	3.99
LMB Mainstream dam	23-May	123	-33,095	4.96	28-Sep	226	61,366	4.03
LMB tributary dam	23-May	122	-32,043	4.91	28-Sep	226	59,973	4.02
20 year plan development	26-May	120	-31,296	4.89	28-Sep	225	60,241	4.04
Difference	**(days)**	**(days)**	**(%)**	**(m)**	**(days)**	**(days)**	**(%)**	**(m)**
Chinese Dam	0	1	-5.2	-0.10	-3	-2	-3.8	0.07
Definite future	2	2	-7.5	-0.19	-1	-2	-5.4	0.08
LMB Mainstream dam	0	2	-8.8	-0.22	-2	-5	-6.4	0.13
LMB tributary dam	0	1	-12.1	-0.27	-2	-4	-8.7	0.11
20 year plan development	-3	-1	-14.8	-0.29	-2	-6	-8.5	0.14

Changes in flood duration in dry year
Definite Future vs. Baseline

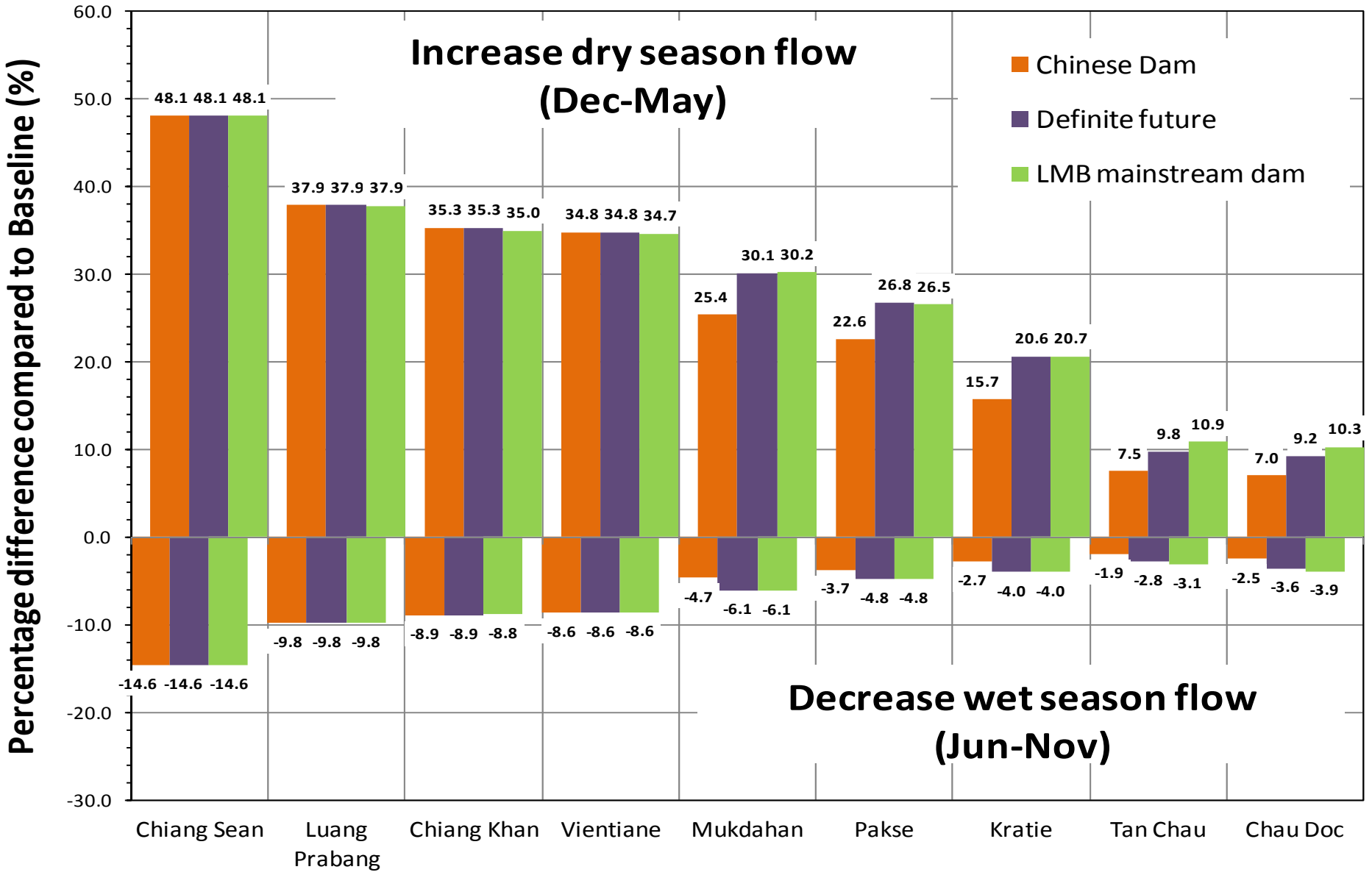




Finding 2 – LMB Mainstream Dam Scenario vs. Definite Future

- The **LMB Mainstream Dam Scenario** will not change the hydrological regime of the river over and above the Definite Future Scenario, since the 11 planned mainstream dams in LMB are being designed to operate as run-of-river projects

- Thus, the LMB mainstream dams do not affect the flood pulse, flooding and salinity intrusion

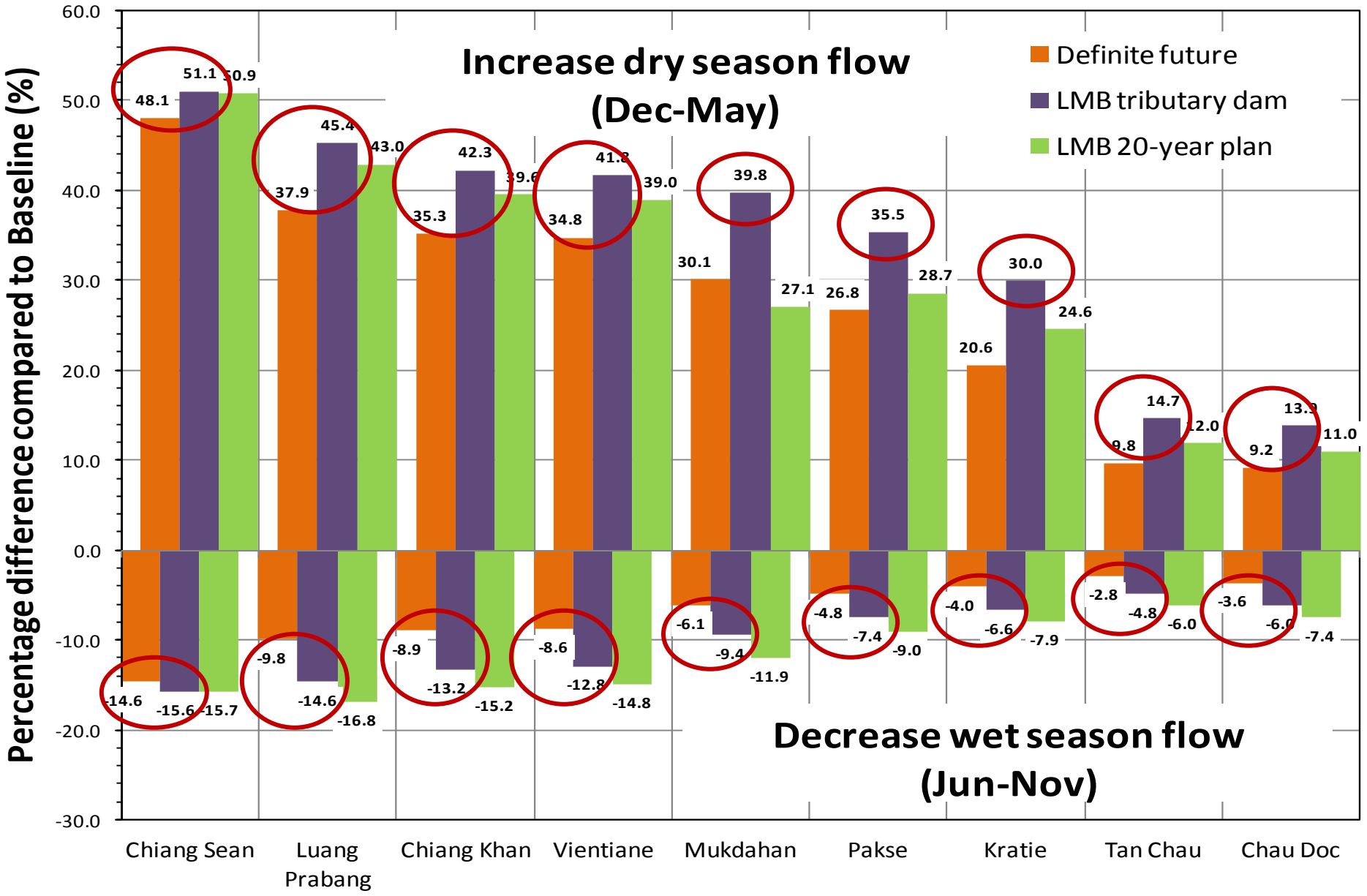


Average flow changes of some scenarios in the dry and wet seasons compared with Baseline scenario

Finding 3 – LMB Tributary Dam Scenario vs. Definite Future

- The **LMB Tributary Dam Scenario** will increase the average dry season flows by 5-10% in the mainstream over and above the Definite Future Scenario

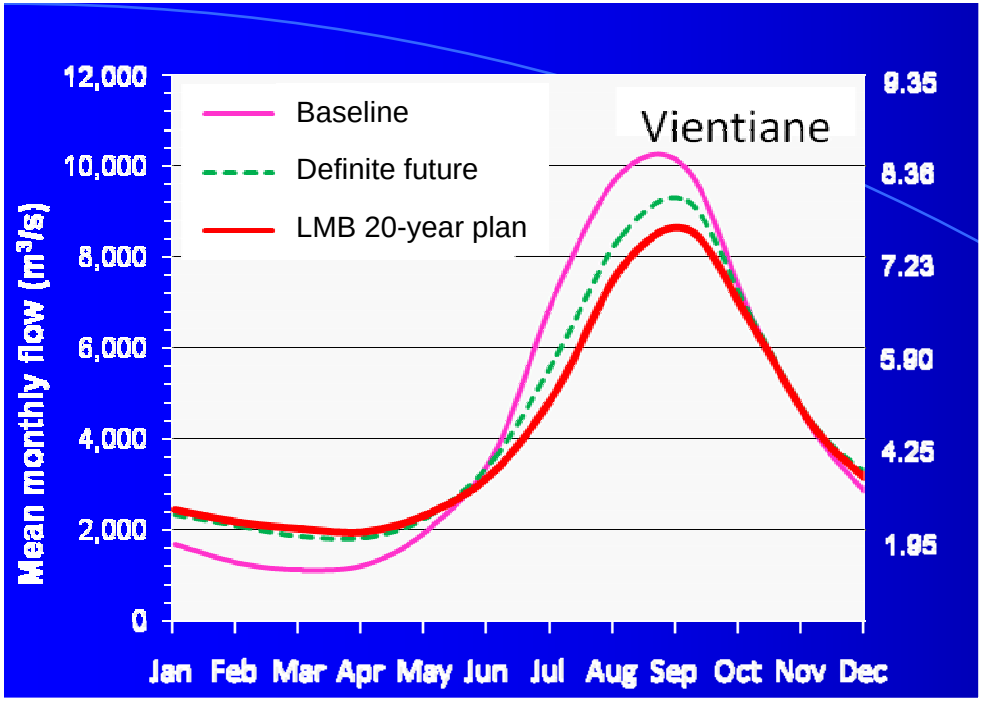
- The incremental reduction in wet season flows amounts to 1-5%

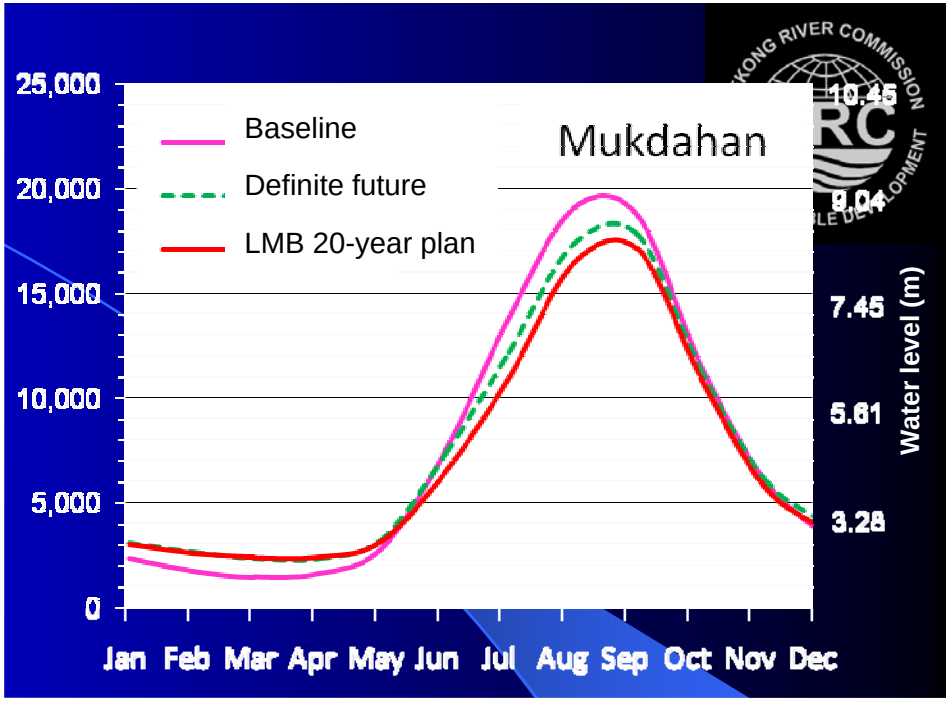


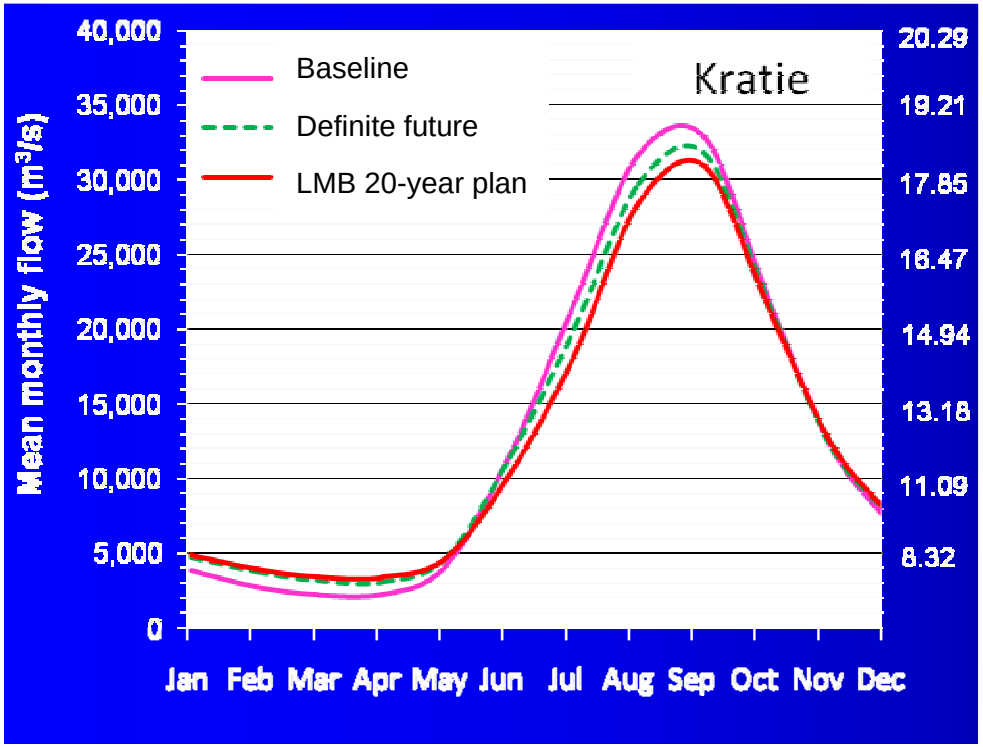
Average flow changes of some scenarios in the dry and wet seasons compared with Baseline scenario

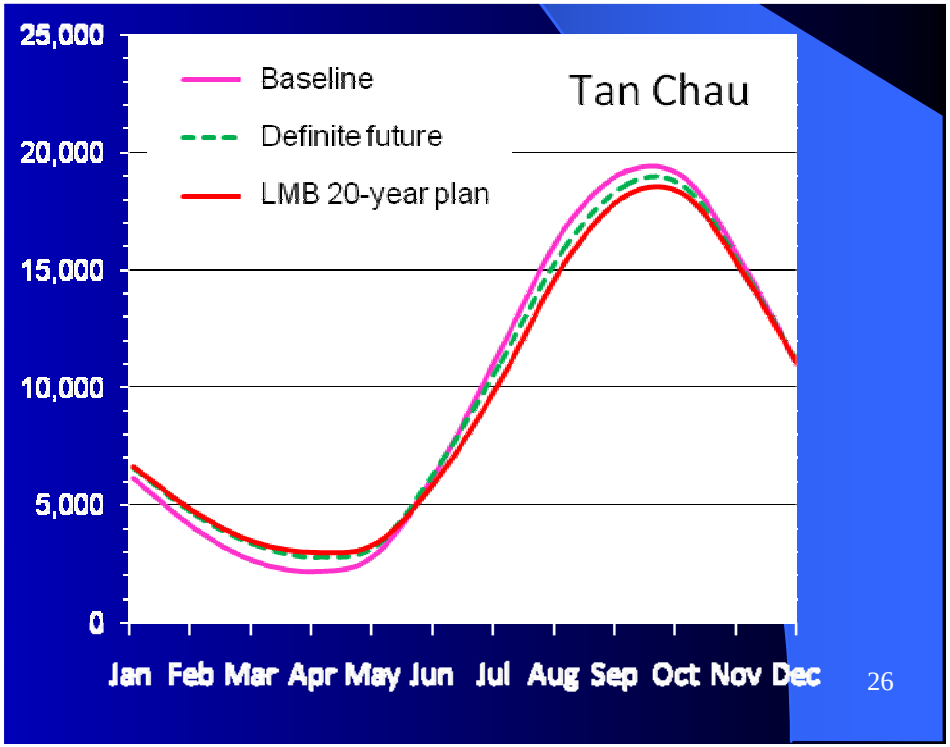
Finding 4 – LMB 20-Year Plan Scenario vs. Definite Future

- The average flow and level changes caused by the **LMB 20-Year Plan Scenario** in the mainstream are typically less than 5% over and above the Definite Future Situation
- The changes are smaller compared to the LMB Tributary Dam Scenario because increased irrigation offsets the changes caused by hydropower development
- In about 10% of the surface area of the Vietnam Delta, the duration of salinity intrusion will be reduced by 5 to 15 days


Vientiane
Baseline
Definite future
LMB 20-year plan
Mean monthly flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
9.35
8.36
7.23
5.90
4.25
1.95
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

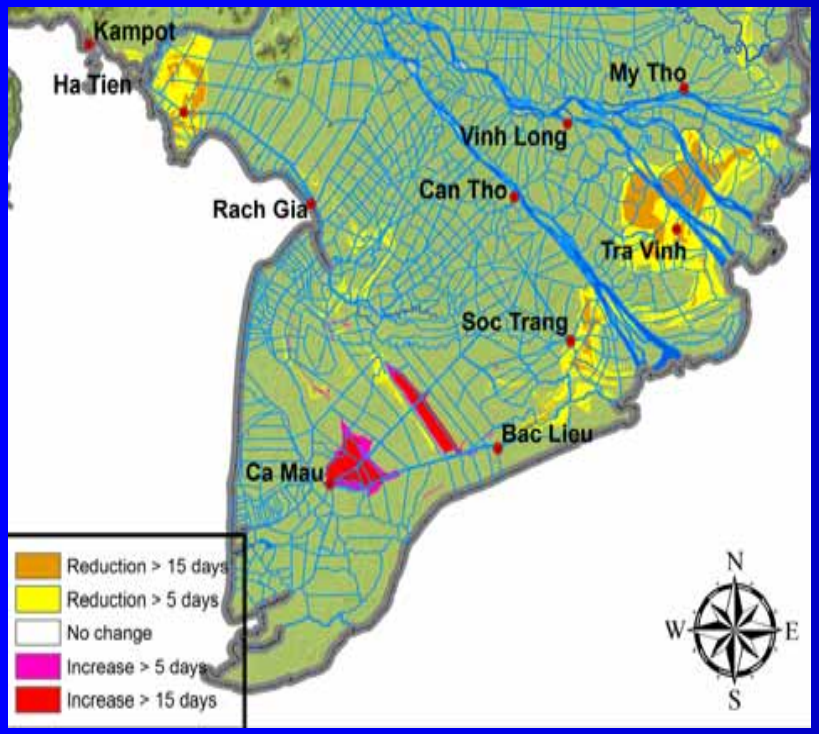

Mukdahan
Baseline
Definite future
LMB 20-year plan
25,000
20,000
15,000
10,000
5,000
0
10.45
9.04
7.45
5.61
3.28
Water level (m)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Kratie
Baseline
Definite future
LMB 20-year plan
Mean monthly flow (m³/s)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
20.29
19.21
17.85
16.47
14.94
13.18
11.09
8.32
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

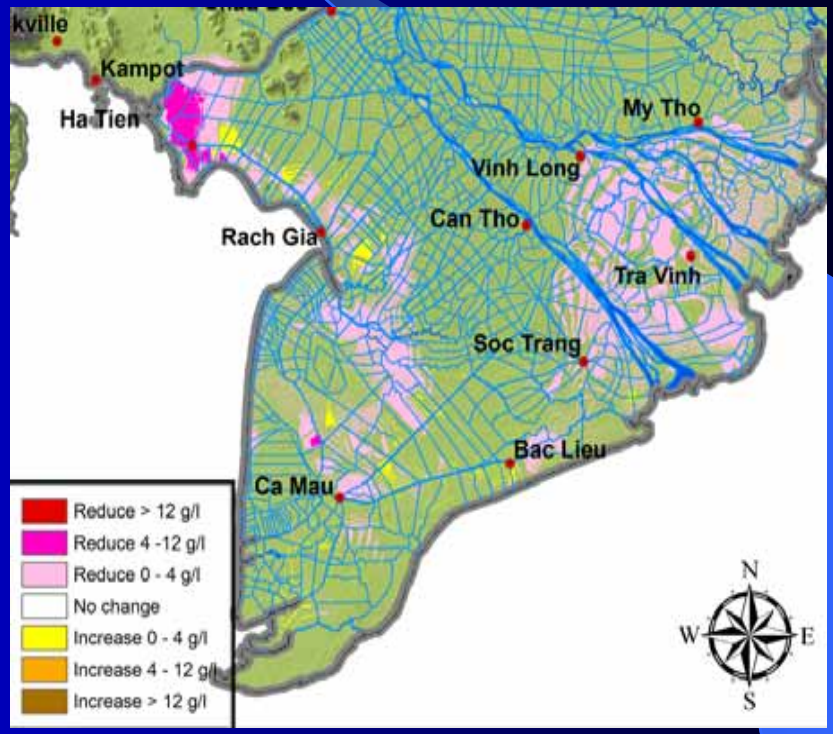

Tan Chau
Baseline
Definite future
LMB 20-year plan
25,000
20,000
15,000
10,000
5,000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Changes in salinity concentration and duration in a dry year

LMB 20-year plan vs. Definite Future



Salinity Duration (days)



Salinity concentration (g/l)

Finding 4 – LMB 20-Year Plan Scenario (Continued)

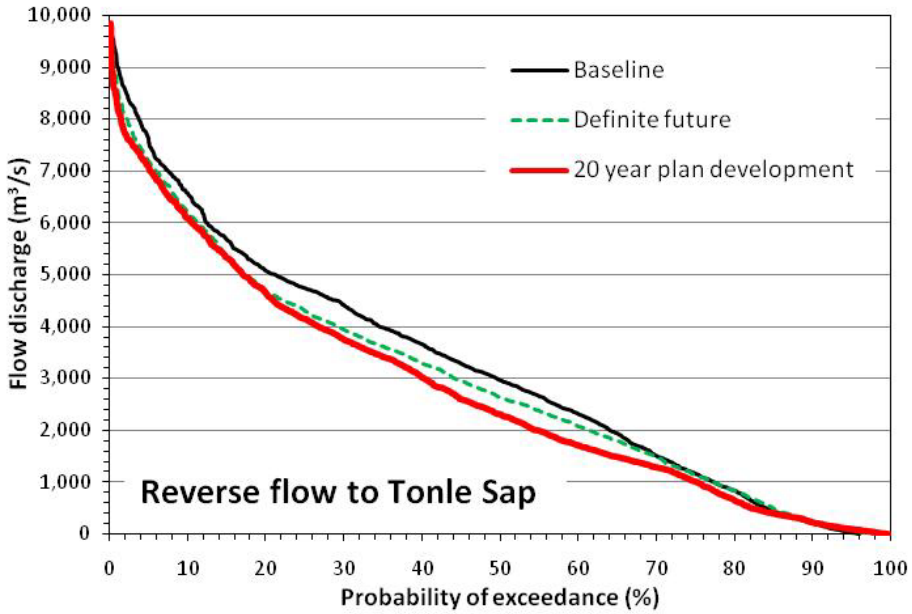
- This Scenario will marginally change the volume, duration and timing of the flood pulse over and above the Definite Future Scenario. The calculated changes constitute a fraction of the historically observed natural year-to-year variability:

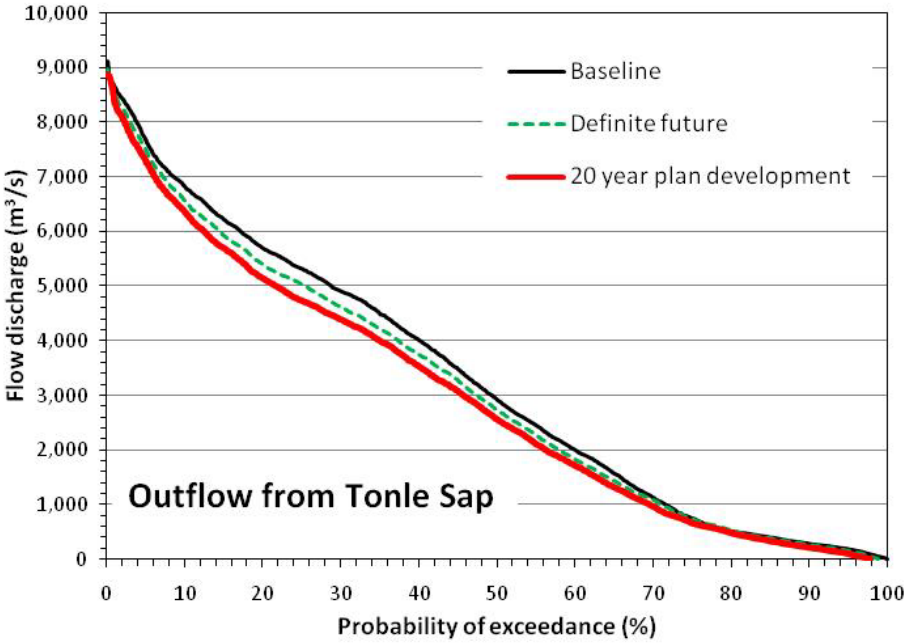
  - Reduction of up to 7.3% of the reverse flow and 3.1% of the outflow from the Tonle Sap Lake

  - Reduction in the range of 5-15 days (less than 10%) in flood duration and increase of more than 5 days in the Tonle Sap Lake

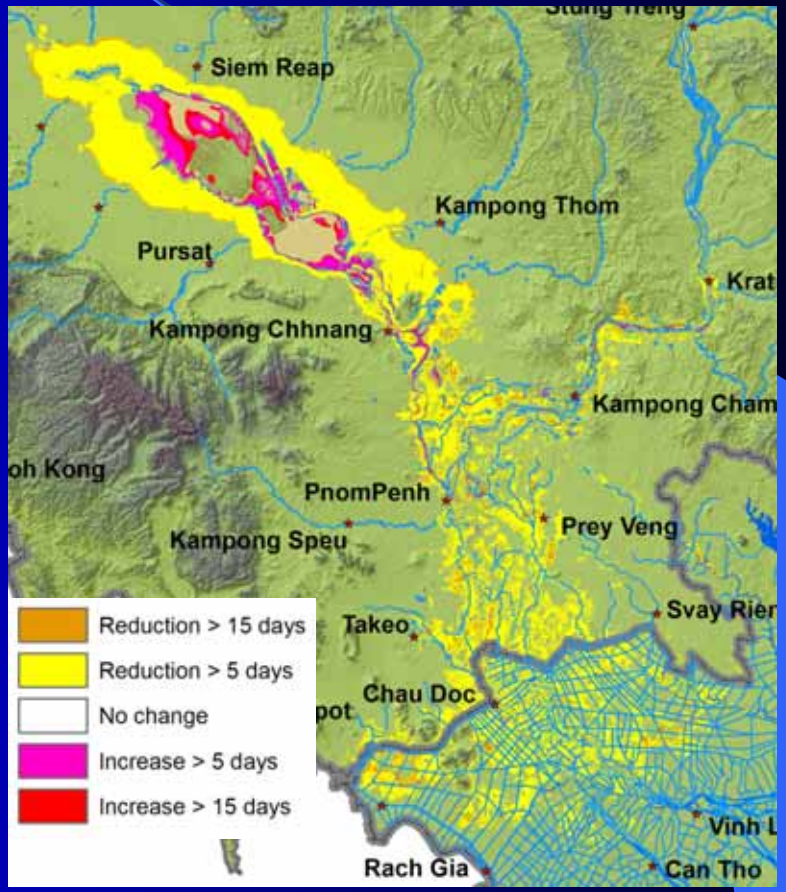
  - Timing of flooding changes with 1-5 days

Flow duration at Prek Kdam





LMB 20-Year Plan vs. Definite Future



Changes in flood duration in a dry year

In Conclusion

- The pattern of distinct dry and wet flow seasons in the Mekong mainstream is maintained under all considered scenarios
- In the foreseeable future (next 20 years), the main flow changes in the Mekong mainstream will be caused by hydropower development in the Upper Mekong Basin
- The flow changes caused by possible water resources developments in the LMB will result in small mostly positive changes in salinity intrusion in the Vietnam Delta and relatively small changes in flooding patterns around the Tonle Sap compared to the natural year-to-year variability
- The LMB mainstream dams would not cause flow changes beyond a daily timeframe

How Robust Are the Findings?

- The range of defined scenarios is sufficient to illustrate the likely flow changes during the next 20 years

- Findings related to mainstream flow changes will neither change significantly for other possible 20-year water resources development scenarios nor for improved data

- The findings might change, however, for longer term scenarios

4. Next Steps

Next steps

- Complete the hydrological assessment of the considered scenarios (sediment, water quality, etc) by the end of 2008
- Scoping and implementation of an environmental, social and economic impact assessment of the LMB water resources development scenarios by mid 2009
- Examine the impacts of longer term water resources development scenarios (including climate change) in 2009

Thank You